MACHINE DESIGN

1978 ANNUAL INDEX

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Including 23 regular issues of MACHINE DESIGN plus five special issues—*The Materials Reference Issue, Electrical & Electronics Reference Issue, Mechanical Drives Reference Issue, Fluid Power Reference Issue, Fastening & Joining Reference Issue.* Only articles and editorial items one-half page or larger are indexed.

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(1) Title.

(2) Author's last name (see AUTHOR INDEX for full name).
Departments in regular issues are denoted by the codes:

N/T .....News/Trends
DI .....Design International
Scan .....Scanning the Field for Ideas

Articles in MACHINE DESIGN *Reference Issues* are identified by the entry: Chapter (*Ref. Issue* code).
Reference Issues are coded as follows:

M .....Materials
E&E .....Electrical & Electronics
MD .....Mechanical Drives
FP .....Fluid Power
F&J .....Fastening & Joining

(3) Date of regular or *Reference* issue.
(4) Page number.
(5) Number of pages in article or item.

ELECTRICAL & ELECTRONIC

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Rare-Earth Magnets Power New Actuators	Curry	9/7	94	(6.0)
Shifting Poles Shape Movable Magnets	Scan	10/26	40	(0.6)
Sticky-Back Magnetic Tape to Solve Many Problems	N/T	12/7	6	(0.7)
Designing Safe Electronics	Article	2/9	111	(1.3)
Dilated Tubing Shrinks Without Heat	Scan	10/26	38	(0.5)
Lightweight Heaters Form Complex Shapes	Scan	7/6	38	(0.6)
Removing Shock Hazards from Power Tools	Gross	2/9	98	(4.0)
Circuit Breakers	Chapter E&E	5/18	150	(4.5)
GFI Switch Fits Receptacle Box	N/T	8/24	27	(0.5)
Glasses Photographically Accept Full Spectrum of Permanent Color	N/T	5/25	12	(0.6)
Parts Machined to Optical-Quality Polished Finishes	N/T	7/20	10	(0.7)
Fiber Optics Keep Copy Machine in Focus	Scan	8/24	38	(1.0)
Bright Future for Fiber Optics	Polishuk	8/24	114	(5.0)
Optical Communications Ahead of Schedule	N/T	12/7	12	(0.6)
Independent Coils Drive Double-Duty Speaker	Scan	1/26	46	(0.5)
Radar Watches Far-Away Air Traffic	N/T	5/25	8	(0.5)
Human Arm Makes a Good Antenna	Scan	11/23	40	(0.6)
Interconnections	Chapter E&E	5/18	277	(13.0)
Capacitive Connector Transmits Digital Data	Scan	1/26	48	(0.5)
Selecting Electrical Connectors	Spatz	1/26	105	(11.0)
Rubber-Band PC Connector Provides High Contact Density	Scan	6/22	40	(0.5)
Ratchet Clamp Boosts Battery Cable Grip	Scan	10/26	42	(0.5)
Coming: Superconductors in New Forms	N/T	8/24	6	(0.6)
Preforms Speed PC Board Soldering	Scan	1/26	44	(0.5)
Designing Circuit Boards the Easy Way	Bollinger	3/9	110	(6.0)
Printed-Circuit Boards Called Design Afterthoughts	N/T	7/6	4	(1.0)
Cardboard Circuits Form Throwaway Electronics	Scan	8/10	38	(0.5)

17. Control Systems & Computers

'Smart' Press Punches Holes on Target	Scan	2/9	41	(1.0)
Machine Controllers	Chapter E&E	5/18	225	(8.0)
Calculus Taught with Calculators	N/T	2/9	4	(0.7)
Programmable Calculator as a Test Controller	Bradshaw	4/20	64	(1.5)
New Realism for Computer Graphics	Teschler	2/23	93	(7.0)
Educating the Consumer Called Key to Marketing Home Computer	N/T	3/23	10	(0.6)
Computer Heckles Opponent While Playing Chess	N/T	5/25	4	(1.3)
Conversational Computers	Baker	10/12	178	(7.0)
Stored Energy Powers Printhead	Scan	2/9	42	(0.5)
Machine 'Reads' Speech, Produces Computer Inputs	N/T	2/23	8	(0.6)
Solid-State Typewriter Interfaces with Copy Machine	Scan	3/9	52	(0.6)
Copy Machine Generates Original Graphics	Scan	10/26	37	(1.0)
Restoring Readability to CRT Displays	Damian	11/9	135	(1.5)

18. Power Supplies, Conditioners & Controls

Iron-Nickel Battery Powering a Coal Hauler	N/T	2/9	12	(0.7)
Ni-Zn Battery Readied to Double Range of Electric Cars	N/T	3/9	4	(1.7)
Rechargeable Lithium Battery Looks Good for Many Jobs	N/T	4/6	6	(0.7)
Charging Lead-Acid Batteries	Scarvaci	11/9	137	(1.5)
Hollow Electrodes Boost Fuel-Cell Performance	Scan	1/12	52	(0.5)
Low-Cost Photovoltaic Cell Patented	N/T	1/26	18	(0.5)
Power-Control Modules	Chapter E&E	5/18	248	(2.0)
Building Your Own Power Converter	Wood	7/6	58	(6.0)
Building an Adjustable-Voltage Power Supply	Alfke	9/21	144	(1.7)
Superconducting Magnet to Store Power Plant's Excess Electricity	N/T	8/10	6	(0.5)

19. Instrumentation

Electrical & Electronic Devices 1978	Chapter E&E	5/18	2	(6.0)
Three New Sensors Tailored to Automotive Engines	N/T	1/26	10	(0.7)
Prestressed Resistors Form Linear Force Transducer	Scan	2/23	42	(0.5)
Suction Speeds Transducer Mounting	Scan	3/23	42	(0.6)
Coiled Tubing Eliminates Pressure Probe Reflections	Scan	3/23	46	(0.7)
Vibrating Wire Measures Structural Stresses	Scan	4/6	70	(0.5)
Digital Servo Measures Angular Displacement	Article	4/6	259	(1.5)
Modified Thermometer Measures Solar Intensity	Scan	5/25	40	(0.5)
Floppy Washer Triggers Tiny Damage Sensor	Scan	6/8	44	(0.5)
Strain Gage Senses Piston Position	Scan	8/10	44	(0.5)
Capturing Elusive Transducer Signals	Riskin	10/12	160	(6.0)
Conditioning Strain-Gage Signals	Article	10/26	114	(1.1)
Transverse Antennas Confirm Conveyor-Belt Rips	Scan	11/9	40	(0.5)
Stacked Solar Cells Sense Short-Time X-Ray Exposure	Scan	12/7	58	(1.0)
Hand-Held X-Ray Machine Goes to the Patient	N/T	1/26	12	(0.6)
Understanding Digital Panel Meters	Castelli	4/6	257	(2.0)
Magnetic Tape Monitors Lightning Bolts	Scan	5/11	42	(0.5)
BTU Meter Measures Solar-System Efficiency	Scan	9/7	40	(0.6)
New Digital Multimeters	Muller	7/20	79	(5.0)
Supporting Software-Based Systems: Part 1—Software-Design Instrumentation	Ramey, Fischer & Orchard	12/7	145	(6.0)
Probability Meter Performs Statistical Analysis	Scan	4/6	62	(1.0)
Attacking Structural Vibration Through Spectrum Analysis	Heimbigner	6/8	108	(6.0)

FLUID POWER

21, 22, 23. Fluids, Fluid Conditioners, Fluid Conductors

Safer Pressurized Fluid Systems	Muldoon	1/26	90	(4.0)
Hydraulic Accessories	Dyer	6/22	80	(5.0)
Selecting Hydraulic Components by Fatigue Strength	Skaistis	7/20	74	(5.0)
Fluid Systems 1978	Chapter FP	9/28	2	(5.0)
Fluids	Chapter FP	9/28	112	(2.7)
Reservoirs	Chapter FP	9/28	18	(1.8)
Pop-Top Pulp Tank Relieves Plus Pressure	Scan	11/9	44	(0.5)
Filter Weir Cuts Contamination	Scan	9/7	44	(0.5)
Hydraulic and Pneumatic Filters	Chapter FP	9/28	116	(3.3)
Pneumatic Lubricators	Chapter FP	9/28	124	(0.7)
Compact, Low-Cost Heat-Storage System Looking Good for Home Use	N/T	1/26	8	(0.8)
Heat Exchangers	Chapter FP	9/28	124	(2.3)
Tap Ocean's Thermal Energy? Heat-Exchanger Design Holds the Answer	N/T	12/7	10	(0.7)
Heat Pipes Cool Flat Surfaces	Scan	8/24	40	(0.6)
Vapors Cool Universal Transformer	Scan	8/24	42	(0.5)
Pipe and Tubing	Chapter FP	9/28	103	(2.1)
System Safety	Chapter FP	9/28	259	(1.4)
Hydraulic Hose	Chapter FP	9/28	107	(0.6)
Tube Fittings for Those Extra-Tough Jobs	Fasser	9/7	100	(4.0)
Tube Fittings	Chapter FP	9/28	105	(1.4)
Hose Fittings	Chapter FP	9/28	107	(0.7)
Stapled Coupling Simplifies Hose Connections	Scan	4/6	70	(0.5)
Quick-Disconnect Couplings	Chapter FP	9/28	108	(1.3)

24. Linear Devices

Structural Ports Eliminate Air-Cylinder Tie Rods	Scan	3/23	44	(0.6)
Hydrostatic Testing of Cylinder Tubes	Dann	4/6	192	(4.0)
Cylinders: Softening the Blow	Rich	5/25	66	(4.0)
Cylinders	Chapter FP	9/28	170	(4.5)

Shop Air Boosts Hydraulic Cylinder Forces	Scan	10/12	56	(1.0)
Cylinder Cushion Doubles as Check Valve	Scan	12/7	54	(0.6)
Keeping Hydraulic Cylinders Healthy	Rich	12/7	156	(4.0)
Suction Accumulators Boost Pump Life	Zahid	3/9	97	(3.0)
Seaworthy Accumulator Balances Hydraulic Systems	Scan	9/21	50	(0.7)
Accumulators	Chapter FP	9/28	14	(1.9)
Boosters	Chapter FP	9/28	13	(0.9)
Free-Floating Cylinder Rides in a Socket	Scan	2/9	44	(0.5)
Pressurized Hydraulics Provide 'Instant' Response	Scan	11/23	44	(1.0)

25. Rotary Devices

Simple Pump Helps Vibrator Boost Forces	Scan	1/26	46	(0.5)
Hydraulic Pumps	Chapter FP	9/28	9	(3.6)
Positive-Displacement Pumps	Chapter FP	9/28	260	(1.7)
Centrifugal Pumps	Chapter FP	9/28	262	(1.3)
Pumping Problem Fluids	Fried	11/9	131	(4.0)
Fluid Motors	Chapter FP	9/28	165	(3.7)
Air Motors Challenge Electrics	Brooks	9/21	130	(4.0)
Prolonging Compressor Life	Moffatt	5/11	98	(4.0)
Compressor & Motor Share a Common Housing	Scan	5/25	42	(1.0)
Compressors	Chapter FP	9/28	23	(2.0)
Vacuum Pumps	Chapter FP	9/28	25	(1.3)
Rotary Actuators	Chapter FP	9/28	178	(1.1)

26. Seals

Slippery O-Rings Minimize Stick-Slip	Scan	6/8	46	(0.5)
Seals	Chapter MD	6/29	237	(12.0)
O-Rings and Other Squeeze Packings	Chapter FP	9/28	219	(2.3)
Phenolic Rings Extend Cylinder Life	Scan	10/12	52	(0.6)
Materials for Low-Temperature Seals	Article	11/23	109	(1.3)
Face Seals	Chapter FP	9/28	222	(1.0)
Nonmetallic Gaskets	Chapter MD	6/29	258	(5.5)
Exclusion Seals	Chapter FP	9/28	228	(0.8)
Compression Packings	Chapter MD	6/29	250	(7.7)
Compression Packings and Seals	Chapter FP	9/28	221	(0.8)
Pressure-Energized Seals	Chapter FP	9/28	224	(2.0)
Diaphragm Seals	Chapter MD	6/29	257	(0.8)
Involuted Diaphragm Saves Space	Scan	8/10	44	(0.5)
Flocked Washer Forms Bearing Seal	Scan	6/22	42	(0.5)
Deflecting Disc Forms Lube Barrier in Lab Seals	Scan	11/23	42	(0.5)

27. Valves

How Valves Answer Commands	Chapter FP	9/28	59	(1.8)
Putting Valves in Circuits	Chapter FP	9/28	72	(0.7)
Coming: Smart Hydraulic Valves	Ibiary	11/23	99	(5.0)
Fluid Pressure Seals Quarter-Turn Valve	Scan	1/26	48	(0.5)
Double Valves for Fail-Safe Applications	Dann	4/20	65	(2.0)
Direction-Control Valves	Chapter FP	9/28	60	(2.0)
Buried-Service Valve Gets Plastic Disc	N/T	4/20	10	(0.5)
Hydraulic Pressure and Flow Valves	Chapter FP	9/28	63	(2.2)
Fluid-Handling Valves	Chapter FP	9/28	263	(3.4)
Servovalves	Chapter FP	9/28	68	(2.1)
Hydraulic Manifolds	Iwatsuki	6/8	104	(4.0)
Manifolds	Chapter FP	9/28	106	(0.8)
Adjustable Resonator Regulates Sonic Spray	N/T	9/21	46	(0.7)

28. Instruments & Controls

Movable Meters Determine Oscillating Flows	Article	2/9	110	(1.2)
Gages and Meters	Chapter FP	9/28	74	(3.6)
Remote Flowmeter Monitors Casting Operations	Scan	12/7	56	(0.5)
Designing Jet Pipes	Holzbock	2/23	111	(1.5)
Multiport Sensor Averages Flow Velocities	Scan	6/8	40	(0.7)
Blocked Orifice Sends Pressure Signals to Remote Limit Switch	Scan	11/9	44	(0.5)
Pneumatic Pressure Regulators	Chapter FP	9/28	72	(0.7)
Fluidic Oscillator Takes Turbine's Temperature	Scan	2/23	46	(0.5)
Moving-Part Logic	Chapter FP	9/28	276	(2.1)
Fluidics	Chapter FP	9/28	279	(1.6)
Tester Measures Air in Oil Lines	Scan	2/23	44	(0.5)

29. Systems & Assemblies

Small Hydraulics with Big Muscles	Dann	7/6	64	(4.0)
Power Units	Chapter FP	9/28	18	(0.7)
Pressure Drop Activates Self-Contained Fire Quencher	Scan	1/26	42	(1.0)
Layouts for Vehicular Hydrostatic Drives	Clifford	10/12	185	(1.5)
Sizing Hydrostatic Transmissions	Klein & Norris	1/26	102	(1.5)
Hydrostatic Drives	Chapter FP	9/28	168	(2.0)
Gears Put Muscle in Hydrostatic Drives	Sculthorpe & Lemon	10/26	101	(5.0)
Seal-less Valve Regulates Material Flow	Scan	7/6	40	(0.5)

MECHANICAL

31. Power Sources

What's Ahead for Materials and Processes?	N/T	2/9	18	(1.0)
Energy Storage: How Do You Preserve Watts and Btu?	Aronson	1/12	30	(6.0)
Rotary Gate Meters Fuel in Injection System	Scan	2/9	42	(0.5)
Engines	Chapter MD	6/29	58	(1.5)
Evolution of an Engine	Wise	7/6	20	(5.0)
Supersonic Plasma Boosts Engine Performance	Scan	8/24	45	(0.6)
Two-Stage Engine Consumes Its Own Exhaust	Scan	10/12	50	(1.0)
Reason Enough for the Breeder?	Wise	2/9	26	(6.0)
Fusion Advances Achieved in 'Simple' Apparatus	N/T	4/20	8	(0.5)
Most Powerful Switch Tube Going into Fusion Test Reactor	N/T	5/11	10	(0.7)
Power in Pill Form	Zimmerman	3/9	86	(4.0)
Record Set by MHD Generator	N/T	9/21	6	(0.5)
Home Fueled with Hydrogen	N/T	1/12	6	(0.6)
Cleaning Up King Coal	Aronson	5/25	18	(5.0)
Fuel Injector Tames Hydrogen Engine	Scan	6/8	42	(0.6)
Seawater Plus Sewage Yields Lots of Fuel Gas	N/T	2/9	10	(0.9)
Knitwear Plant to Run on Solar Energy	N/T	2/23	6	(0.7)
Solar Progress Down Under	Scholes	3/9	26	(4.0)
Oceans' Thermal Energy to be Tapped	N/T	3/23	4	(0.7)
There's Electricity in the Wind in Clayton, N.M.	Wise	3/23	30	(2.0)
Power Tower Progress Report	N/T	4/6	18	(0.7)
California Raisins Dried by Sun Energy	N/T	6/8	4	(0.6)
Solar Panel Acts as Window and Window Shade	N/T	6/8	6	(0.5)
Sea World of Florida Going Solar	N/T	6/22	8	(0.5)
Build Your Own Windmill?	N/T	7/6	18	(0.5)
Experimental Houses Saving Energy	N/T	9/7	12	(0.5)
Passive Solar System Keeps Dog House Snug	N/T	9/21	4	(0.6)
Coming: 10 MW of Solar Electricity Fed into Transmission Network	N/T	10/12	12	(0.8)
'Merry-Go-Round' to Harness Wind Energy	N/T	10/26	4	(0.6)
Grass-Roots Energy	Aronson	10/12	20	(4.0)

32, 33, 34. Drives, Transmissions, Drive Components

Redundant Design Improves Gearhead Reliability	Scan	7/6	36	(0.5)
Regulating Speed Mechanically	Krouse	3/9	104	(6.0)
Adjustable-Speed Drives	Chapter MD	6/29	7	(6.8)
Planetary Bearings Form Gearless Reducer	Scan	4/20	26	(1.0)
Higher Load and Speed Limits for Silent Chain	McCarty & Stevenson	1/12	121	(5.0)
Chains	Chapter MD	6/29	21	(2.3)
Troubleshooting V-Belt Drives	Philleo	3/23	79	(0.7)
Belt Drives	Chapter MD	6/29	26	(4.2)
Synchronous Belts for High-Power Drives	Zaiss	11/9	122	(4.0)
New Belt to Compete with Chain	N/T	11/23	6	(0.7)
Gear-Tooth Stresses	Wilcox	2/23	88	(5.0)
Calculating Gear-Support Stiffness	Wallach	3/9	117	(1.3)
Huge Gearing System Drives Compressors Under Test	N/T	5/25	6	(0.7)
Gears and Gear Drives	Chapter MD	6/29	13	(6.7)

35. Rotational Components

Bearings	Chapter MD	6/29	137	(3.7)
Meeting Heavier Demands on Bearings	Philippbar	3/23	60	(6.0)
Positive Lubrication Keeps Motor Bearings Running	Scan	4/6	64	(0.5)
Noise from Bearing Defects	Gordon	5/11	113	(1.0)
How to Use Spherical-Roller Bearings: Part 1—Selection Factors	Hafner	6/8	95	(5.0)
How to Use Spherical-Roller Bearings: Part 2—Mounting and Lubrication	Hafner	6/22	85	(3.0)
Rolling-Element Bearings	Chapter MD	6/29	156	(11.3)
Premounted Bearings	Chapter MD	6/29	175	(2.7)
Specialty Bearings	Chapter MD	6/29	178	(10.5)
How Dirt and Water Slash Bearing Life	Beercheck	7/6	68	(6.0)
Unitized Bearing Simplifies Wheel Support	N/T	9/7	38	(0.6)
Calculating Bearing Speed Ratio	Article	9/7	118	(1.0)
Preloaded Pyramid Stabilizes Positioning Platform	Scan	9/7	44	(1.0)
The Special Way Big Bearings Can Fail	Sague	9/21	113	(5.0)
Boundary-Lubricated Sleeve Bearings	Glaeser & Dufrane	4/6	207	(7.0)
Whirl-Resistant Sleeve Bearings	Article	4/20	67	(1.5)
Capillary Grooves Eliminate Bearing Drip	Scan	6/22	45	(1.0)
Plain Bearings	Chapter MD	6/29	140	(6.1)
Sliding-Bearing Materials	Chapter MD	6/29	146	(6.2)
Industrial Bearing to Float on a Magnetic Field	N/T	11/23	8	(0.7)
Foil Bearings Shed Aerospace Image	Beercheck	11/23	104	(4.0)
Break-Apart Coupling Rides on Ribbed Joints	Scan	3/9	48	(0.5)
Constant-Velocity U-Joints	Sutherland	4/20	55	(5.0)
Couplings	Chapter MD	6/29	44	(3.0)
Universal Joints	Chapter MD	6/29	50	(1.1)
The Right Flexible Coupling	Beercheck	8/24	100	(6.0)
Classifying Clutch-Brake Applications	Article	1/12	129	(1.0)
Additive Silences Squeal and Stops Fade in Asbestos-Free Brake Pads	N/T	6/22	10	(0.5)
One Brake Fluid Replaces Three in Army Vehicles	N/T	6/22	18	(0.5)
Clutches and Brakes	Chapter MD	6/29	33	(6.3)
Poor Fan Performance: Whose Fault?	Lanier	1/12	110	(4.0)
New Options in Choosing Blowers	Roppenecker	3/23	66	(5.0)

36, 37. Mechanisms, Controls

Auxiliary Components	Chapter MD	6/29	52	(2.2)
Mechanism Design by Computer	Kaufman	10/26	94	(7.0)
Custom Cams From 'Building Blocks'	Pagel	5/11	86	(5.0)
Sizing Cams for Long Life	Pagel	9/7	104	(6.0)
Calculating Cam Profiles Quickly	Davidson	12/7	151	(5.0)
Cam-Driven Pull Rods Revolutionize Bike Design	Scan	7/20	37	(1.0)
Cross-Link Mechanisms	Hadekel	7/20	64	(4.0)
Modified Geneva Positions Indexing Table	N/T	7/20	38	(0.5)
Thermal Spit Powers Itself	Scan	4/6	69	(0.5)

38. Subsystems

Air Conditioners for Machines	Krouse	2/9	89	(5.0)
Motor Oil: Crude with a Touch of Alchemy	Wise	4/6	38	(6.0)
Solid Lubricant Extends Bearing Life	Scan	4/20	28	(0.5)
Calculating Minimum Lubricant Film Thickness	Hamrock & Dowson	5/11	114	(1.5)
Motor's Starting Current Cut by Half	N/T	6/22	12	(0.7)
Lubrication and Energy Usage	Chapter MD	6/29	2	(2.0)
Lubricants	Chapter MD	6/29	194	(4.1)
Lubricating Systems	Chapter MD	6/29	203	(2.1)
Lubricant Film Thickness in Flexible Parts	Hamrock	7/6	74	(1.5)
Gassed-Up Reservoir Provides Continuous Lubrication	Scan	11/9	40	(0.5)
GM Developing 'Basic' Robot	Wise	8/24	28	(2.0)

ASSEMBLY COMPONENTS

41, 42, 43. Fasteners, Springs & Isolation Devices, Misc.

Preventing Failure in Bolted Joints. Part 2—Strength Through Design	Bickford	8/24	110	(4.0)
The Fastener Industry/78	Chapter F&J	11/16	2	(2.0)
Design and Assembly	Chapter F&J	11/16	79	(9.0)
Plastic Fasteners	Chapter F&J	11/16	134	(4.2)
Plastic Joining	Chapter F&J	11/16	182	(3.7)
How Locknuts Remove the 'Unknowns' in Joint Design	Aronson	10/12	166	(4.0)
Nuts and Inserts	Chapter F&J	11/16	18	(7.0)
Quick-Operating Fasteners	Chapter F&J	11/16	131	(4.8)
Maintaining Alignment of Parts	Strasser	5/25	81	(1.5)
Elastomer Pad Doubles Flywheel Capacity	Scan	8/10	38	(0.5)
Shaft Collar Eliminates Unexpected Amusement Ride 'Thrills'	Scan	10/26	42	(0.5)
Retaining Rings	Chapter F&J	11/16	100	(3.5)
Non-Threaded Fasteners	Chapter F&J	11/16	95	(5.8)
Fasteners for Thin-Wall Joints	Hawes	2/9	94	(4.0)
Solving the Fastener Preload Puzzle	Aronson	2/23	100	(4.0)
Dimensioning Tapped Holes	Spotts	3/23	55	(5.0)
Failure in High-Strength Bolts	Article	5/11	115	(0.5)
Preventing Failure in Bolted Joints: Part 1—Avoiding Assembly Errors	Bickford	8/10	100	(5.0)
Advanced Fastening System Wins Job on Auto-Engine Production Line	N/T	8/24	8	(0.8)
Circular Lip Seals Threaded Fastener	Scan	9/21	48	(0.5)
How Fasteners Get a Good Grip in Plastics	Aronson	9/21	126	(4.0)
Demand Rising for Fasteners Precoated with Adhesive	N/T	11/9	18	(0.8)
Metric Fastener Designations are Ready to Use	Bitters	11/9	139	(1.0)
Threaded Fasteners	Chapter F&J	11/16	5	(9.0)
Plastic Deformation Seals Blind Rivet Head	N/T	11/23	42	(0.5)
Ultrasonic Pulser Reveals Bolt Preload	Scan	12/7	52	(0.7)
Spring Washer Selection	Remington	2/23	112	(1.5)
Ramped Washers Form Adjustable Shim	Scan	6/8	46	(0.5)
Plastic Spacers Speed PC-Board Mounting	Scan	12/26	38	(0.5)
Washers	Chapter F&J	11/16	107	(1.6)
When, Where, and Why to Use Self-Clinching Fasteners	Segraves	2/9	107	(2.0)
Mini Vise Installs Cramped Cable Clamps	Scan	6/22	40	(0.5)
Cable Clip Saves Siding	Scan	9/7	44	(0.5)
Snap-Together Fastener Teams Strength with Flexibility	N/T	11/9	8	(0.8)
Special-Purpose Fasteners	Chapter F&J	11/16	127	(4.3)
Quick and Easy Spring Calculations	Ome	5/25	82	(1.5)
Tuned Mass Dampers 'Calm' Tall Buildings During High Winds	N/T	3/9	12	(0.8)
Torsional Stiffness of Rubber Shock Mounts	Archibald	4/6	253	(1.0)
Photoelectric Shock Levels Loads	Scan	2/23	40	(1.0)
Smoothing Rotary Motion With Viscous Dampers	Dann	6/22	94	(1.0)
Putting Random Motion to Work	Article	8/10	119	(1.5)
Shock Absorbers	Chapter FP	9/28	182	(1.7)
Reflective Snubbers Speed Inspection	Scan	11/9	42	(0.5)
Nameplates Go Functional	Strause	11/23	84	(5.0)

44. Measurement Equipment

Restricted Beam Clears Up X-Ray Inspection	Scan	4/20	30	(0.6)
Magnetic 'Sonar' Finds Bar Flaws	Aronson	6/22	28	(2.0)
Nondestructive Tester Simulates Ultrasonic Strain Waves	Scan	6/22	38	(1.0)
Liquid Crystals Locate Vacuum Leaks	Scan	8/10	42	(0.5)
Fluorescent Spacer Reveals Peening Problems	Scan	11/9	42	(0.5)
Pivoting Gage Fits in Tight Spots	Scan	12/7	56	(0.5)

MATERIALS

51, 52. Metals

Materials 1978	Chapter M	3/16	2	(4.0)
Your 1985 Car will be Made Primarily from (Pick One): Aluminum, Steel, Plastics	Article	4/20	16	(6.0)
Entropy Sheds Light on the Behavior of Metals	Bates	4/20	46	(4.0)
Ferrous Metals	Chapter M	3/16	6	(20.5)
Dual-Phase Steels Produce Thinner, Lighter Parts	Curry	7/6	54	(4.0)
Nonferrous Metals	Chapter M	3/16	59	(20.0)
The 'Quiet' Alloys	Schetky & Perkins	4/6	202	(5.0)

53, 54. Plastics, Rubber & Elastomer

Plastics	Chapter M	3/16	99	(43.0)
The Polysulfones	Dreger	1/12	114	(7.0)
Alloying Provides Tailor-Made Plastics	Dreger	6/22	88	(5.0)
Designing Molded Plastic Parts	Henry	8/10	114	(5.0)
Higher Conductivity from Filled Plastics	Curry	8/24	120	(1.5)
More Muscle for Rim Parts	Article	10/12	186	(1.5)
New Rigid Thermoplastic Challenges Die Castings and Stamped Metal Parts	N/T	11/9	4	(1.2)
Corvette Gets Plastic Hinged Seat	N/T	3/23	26	(0.6)
Rigidized Acrylics for Better FRP Parts	Dreger	4/6	255	(2.0)
Stronger Plastic Parts with Metal Encapsulation	Article	7/20	85	(1.5)
Glass Bubbles in Plastics	Krouse	9/7	90	(4.0)
Elastomers	Chapter M	3/16	185	(5.5)
New Liquid Silicone Rubber for Injection Molding	Article	9/21	145	(1.2)

55, 56. Joining Materials, Other Nonmetals

Casting Impregnation Catching On as Weight-Saving Technique	N/T	2/9	8	(0.8)
PABST: New Reliability for Adhesive Bonding	Aronson	4/6	20	(5.0)
Sealants	Chapter MD	6/29	266	(2.0)
Adhesive Holds Test Wing Together	N/T	10/12	10	(0.7)
Lumpy Sealant Resists Extrusion	Scan	10/12	54	(0.5)
Anticlog Adhesive Applicator Now on Market	N/T	10/26	8	(0.7)
Adhesives	Chapter F&J	11/16	175	(4.5)
Sealant Helps Cabs Meet Emission Standards	N/T	12/7	8	(0.8)
Other Engineering Materials	Chapter M	3/16	202	(7.0)

Extra Graphite Reduces Friction in Molded Seals	Scan	1/26	44	(0.5)
Revolution in Ceramic Design	Krouse	8/10	94	(6.0)
Braided Sleeve Solves Many Heat Problems	N/T	4/6	8	(0.9)
Floating Helipad Isolates Copter Noise	Scan	4/6	69	(0.5)
Beechwood Rods Hold Insulation in Place	N/T	3/9	10	(0.6)

57. Finishes, Coatings & Lubricants

Powder Blaster Produces High-Strength Coatings	Scan	1/12	49	(0.6)
The Cadmium Connection	Aronson	6/22	70	(4.0)
Vacuum Process Enhances Chrome Plating	Scan	7/6	34	(1.0)
Friction-Reducing Fluoropolymer Coating	Berggren	9/7	116	(1.5)
200,000 ft² of Coating Protect Generating Station	N/T	9/7	23	(0.7)
Coating Stops Rust on Tractors at Sea	N/T	2/23	12	(0.8)
Vaporized Salts Protect Metal Surfaces	Scan	5/25	38	(0.5)

58. Prefabricated Forms

Should You Switch to Precoats?	Curry	5/11	102	(6.0)
Best Alloys Sought for Safe Hydrogen Storage	N/T	11/9	10	(0.5)
Coming: Trucks Mass Produced from Composite Materials	N/T	1/12	4	(0.9)

MANUFACTURING PROCESSES

61, 62, 63. Metal Casting, Shaping, Forming

Support Advanced Manufacturing Technology	N/T	6/22	10	(0.5)
Manufacturing Experts Foresee Increasing Need for Knowledge	N/T	7/20	18	(0.7)
New Ceramic Cores Produce Ferrous Castings to Close Tolerances	N/T	10/12	6	(0.7)
Smooth No-Draft Castings	Dreger	5/25	63	(3.0)
The Engineered Die Casting	Bittence	3/9	100	(4.0)
Big Turbine Vanes Now Forged	N/T	12/7	23	(0.7)
Lower Cost Titanium Parts	Dreger	7/20	20	(3.0)
Selecting PM Alloys	Adams	8/24	106	(4.0)
Progress in Powder Metallurgy	Dreger	11/9	116	(6.0)
Long Holes for Thin Parts	Strasser	1/26	100	(2.0)
Rubber Backstop Cushions Coining Die	Scan	5/11	42	(0.5)
Forming Seamless Rings with Roll Forging	Article	10/26	112	(1.5)

64, 65. Metal Joining, Removal

Welding Processes	Chapter F&J	11/16	167	(2.8)
Off-Beat Projection Weld Joints	Strasser	3/23	76	(1.7)
Computerized Laser Welding Relay Terminals	N/T	10/26	12	(1.0)
No Cleaning Needed After Aluminum is Brazed	N/T	3/23	8	(0.7)
Ceramic Sandwich Formed by Active Metal Brazing	N/T	11/9	6	(0.6)
Brazing Processes	Chapter F&J	11/16	169	(3.4)
Soldering Processes	Chapter F&J	11/16	173	(1.8)
Aluminum Plugs Bond Tubing to Frame	Scan	8/24	42	(0.5)
Plasma-Assisted Machining	Aronson	7/6	75	(1.5)

66. Metal Treating

Stripes Hardened into Metal by High-Frequency Methods	N/T	6/22	6	(0.7)
Cooling Jet Extends Thermocouple Range	Scan	7/20	40	(0.5)
Pinpoint Hardening by Electron Beam	Dreger	10/26	89	(5.0)
Plasma Carburizing Looking Good for Hardening Parts	N/T	11/23	4	(0.5)
Vacuum Bag Forces Defect Impregnation	Scan	4/6	64	(0.5)
Good Vibes Reduce Stresses in Metal Parts	Dreger	6/8	100	(4.0)

67, 68. Finishing, Plastics & Rubber Processes

Ion-Vapor Deposition of Aluminum	Article	6/8	114	(1.5)
Radial Welding Improves Ultrasonic Assembly	Scan	5/11	46	(0.5)

69. Production Machinery & Plant Equipment

Injected-Metal Assembly	Chapter F&J	11/16	175	(0.5)
Toothless Circular Saw Melts Through Metal	N/T	1/12	8	(0.6)
Wire-Wrap Aid Ends Pin Search	Scan	6/22	42	(0.5)
Liquid Solder Dispensed by the Drop	Scan	7/6	40	(0.5)
Preloaded Jaw Improves Vice Accuracy	Scan	2/23	44	(0.5)
Plastic Funel "Spillproofs" Paint Cans	Scan	5/11	44	(0.5)

DESIGN THEORY & TECHNIQUES

71, 72, 73. Design Analysis & Basic Science

Finite-Element Update	Krouse	1/12	98	(6.0)
Quick and Easy Rotor Balancing	Ome	1/12	126	(2.0)
Finding Bearing Moment of Inertia	Dominik	2/9	109	(1.5)
Getting a Closer Reading on Fatigue Life	Castleberry	2/23	108	(3.0)
Simplified Contact Analysis	Brewe & Hamrock	3/9	119	(1.0)
Random Vibration Failures	Steinberg	4/6	188	(4.0)
Resonance in Stubby Cantilevers	Conigliari	4/6	254	(1.5)
Triangular Beam Folds for Storage	Scan	4/20	28	(0.5)
Prefabricated Truss Frames Form 'Instant' Houses	Scan	5/11	46	(0.5)
Conductive Coating Cuts Thermal Stress	Scan	7/20	38	(0.5)
Thermal Stresses in Cylindrical Shells	Tabakman & Lin	9/21	138	(6.0)
Concentrated Moments on Beams	Lipp	9/21	147	(1.0)

Wedge Analysis Made Easy	Franks	10/12	174	(4.0)
Finding Vibration Mode Shapes Quickly	Ricciardiello	10/26	113	(1.5)
Finding True Maximum Shear Stress	Messal	12/7	166	(4.0)
Swinging Way to Find Moment of Inertia	Varmha	12/7	174	(1.0)
Monitoring Machinery Wear Through Particle Analysis	Article	12/7	175	(1.0)
Simple Heat Equations for Electronic Circuits	Conigliari	2/23	104	(4.0)
Preventing Hot Spots in Sliding Contact	Dow	1/26	94	(6.0)
Corrosion Costs $70 Billion Annually	N/T	4/20	10	(0.5)
Tracking Down Equation Roots	Reubens	8/10	120	(0.5)
Specifying Materials Statistically	Bittence	1/26	79	(5.0)
Forecasting the 'Impossible' Takes a Little Longer	Ferris-Prabhu	2/9	84	(5.0)
Designing with Limited Data	Neugebauer	5/25	76	(5.0)
Determining Optimum Lot Size	Agrawal	5/25	84	(1.0)
Short-Cut Reliability Analysis	Rondeau	9/21	108	(5.0)
Fast Dimensional Checks—With Statistics	Spotts	10/12	170	(4.0)
Flight Simulators: Learning in an Illusion	Aronson	4/6	28	(6.0)
Chrysler Puts Cyberman in the Driver's Seat	Wise	4/6	46	(2.0)
Silencing Noisy Machines	Engstrom	1/26	84	(6.0)
Controlling with Ultrasonics	Gross	3/9	90	(7.0)
Wind Tunnel Tipping Off Many Drag Secrets	N/T	8/10	6	(0.5)
Life Found Inside Antarctic Rocks	N/T	2/23	18	(0.7)
City Acts as Heat Island, Affects Downwind Weather	N/T	10/12	18	(0.6)

74. Human Factors

Designing Control Panels	Malecka	8/10	121	(2.0)
Packaging the Human Operator	Zimmerman	10/12	155	(5.0)

75. Legal & Environmental

Designing with the Law in Mind	Dhande & Sandor	8/24	119	(1.5)
Phoenix Waste Collected by One-Man Trucks	N/T	2/23	10	(0.5)
Smog Standard to be Relaxed Slightly	N/T	8/10	4	(0.7)
Lots of Ozone in Country Air	N/T	9/7	6	(0.7)
Philadelphia, Pittsburgh Getting 'Model' Vehicle-Pollution Inspection Programs	N/T	10/12	8	(0.5)
Models Solve Real World Pollution Problems	Article	11/9	20	(2.0)
New Junk-Tire Breakwater Goes to Work	N/T	8/24	27	(0.5)
Saving Energy in the Home	Aronson	6/8	20	(4.0)
Family Ends Year in Tech House	N/T	10/12	4	(1.0)
Feds Support 13 Energy-Saving Ideas	N/T	10/26	23	(0.8)
Time Limit on Patent Procurement	Colman	10/12	188	(1.0)
Crash! Are Cars Safer than Light Aircraft?	Wise	10/12	38	(3.0)

ENGINEERING MANAGEMENT & OPERATION

81. Engineering Department Operations

If You're Going to Delegate, Do It Right	Steger & Karger	3/23	52	(3.0)
Measuring Industry's Commitment to Innovation	Zimmerman	5/25	26	(2.0)
Getting the Most Out of Project Teams	Fuller	5/25	58	(5.0)
What You Should Know About Zero-Base Budgeting	Burroughs	5/11	82	(4.0)
What You Should Know About Accounting	Reilly	12/7	138	(7.0)
Improving the Odds in Product R&D	Leiter	2/9	80	(4.0)
Participation: The Crucial Element in Managing Change	Yeager & Raudsepp	6/22	66	(4.0)
Planning and Budgeting: Keys to Successful R&D	Gibson	7/20	58	(6.0)
Charting a Course to Project Success	Owen	11/23	74	(4.0)
Finding Slider-Crank Acceleration Graphically	Barton	12/7	170	(2.0)
Scheduling Large, Complex Projects	Duran	12/7	172	(2.0)
The Great Overtime Dilemma	Zimmerman	4/6	182	(6.0)
Getting Extra Mileage from Performance Appraisals	Yeager & Raudsepp	11/9	104	(6.0)
A Banner Year for Engineering Employment	Zimmerman	4/20	42	(4.0)
Rating Engineer Performance	N/T	8/24	88	(5.0)
Picking the Right Candidate for That Staff Opening	Moffatt	1/12	92	(6.0)
Is the Engineering Manager Different?	Babcock	3/9	82	(4.0)
Engineer Salaries: Are They Keeping Pace?	Zimmerman	1/26	20	(5.0)
Twelve-Nation Comparison of Earning and Buying Power	N/T	1/26	26	(1.0)
EEs Maintain Salary Advantage	N/T	3/23	20	(4.0)
PE Paychecks Win by a Nose	Zimmerman	6/8	26	(4.0)
Engineering's First Year of the $2,000 Raise	Zimmerman	9/21	34	(3.0)

82, 83. Product Planning, Drafting & Reproduction

Will That New Product Pay Off?	Bronikowski	7/6	50	(4.0)
Mining Foreign Technology	Curry	10/12	150	(5.0)
Dimensioning Stacked Assemblies	Spotts	4/20	60	(4.0)
Magnetic Tracks Simplify Drafting Chore	Scan	5/11	40	(1.0)

84. Laboratory & Testing

Which Vibration Test?	Kolodziej	8/10	110	(4.0)
Severe Shakes Prove Relays Withstand Quakes	N/T	11/23	23	(0.8)
New Sophistication for Simulated Crash Tests	N/T	12/7	4	(0.8)

85. Technical Information

What Future for Voluntary Standards?	Zimmerman	8/10	90	(4.0)
Avoiding the Pitfalls of Parts Classification	Cake	3/9	116	(1.7)
Technology 'Magazine' Going on TV	N/T	11/9	10	(0.5)

87. Personal & Professional

Managing Time: The Priceless Art of Working Smart	Birnbrauer	10/26	84	(5.0)
'78 Design Show Focuses on Microprocessors	Article	4/6	214	(30.0)
Wescon-'78, Biggest of the Decade, In Los Angeles, Sept. 12-14	N/T	8/24	10	(2.0)
West Coast Gets Its Own Design Engineering Show & Conference	N/T	11/23	14	(2.0)
Mandatory Requalification: Is It Coming?	Zimmerman	1/26	74	(5.0)
Students Counseled to 'Design with Integrity'	N/T	2/23	10	(0.5)
Does On-Going Study Really Pay?	N/T	10/12	30	(4.0)
How to Take Charge of Your Career	Ference, Stoner, & Warren	2/23	84	(4.0)
More Room at the Top for Engineers	Zimmerman	3/9	18	(2.0)
Making Your Mark in Washington	Zimmerman	6/8	86	(4.0)
"Unaccustomed As I Am ..."	Gibson	9/7	86	(4.0)

MISCELLANEOUS

91. Complete Machines

Dual-Hardness Skin Stops Armor-Piercing Projectiles	Ogorkiewicz	1/26	32	(1.0)
Impact Filmed as Nose Cone Hits Water Droplet at 7,000 mph	N/T	6/8	6	(0.5)
Liquid Propellant to Fire Tank Gun	N/T	7/20	6	(0.8)
Thor Makes 500th Flight	N/T	7/20	12	(0.6)
NATO Will Get Hybrid Supertanks	Zimmerman	8/10	18	(5.0)
IH Revamps Combine Design	Zimmerman	2/9	20	(3.0)
Underwater Drill Pipe Streamlined by 'Fat Airplane Wings'	N/T	4/6	12	(0.7)
Screw Extruder Enhances Coal Combustion	Scan	6/8	44	(0.5)
Induction Stirring Enhances Continuous Casting	Scan	8/10	40	(0.6)
No Blades in Power Lawn Mower	N/T	9/21	8	(0.6)

Technology in Hollywood	Zimmerman & Teschler	1/12	20	(5.0)
Sonic Sensors Measure Wind Velocity	Scan	5/25	37	(1.0)
U.S. Lags in 'Telecommunications Race'	N/T	10/26	16	(0.6)
Moving Floor Unloads Cargo in a Hurry	Scan	1/12	50	(0.6)
Air Bag 'Tuned' to Small Car	N/T	2/9	6	(0.7)
Return of the Propeller	Aronson	2/23	20	(4.0)
Just Down the Road: The Ultimate Tire	Wise	3/9	22	(3.0)
New-Car Mileage Labels Likely to Change	N/T	3/23	18	(0.7)
Trip Computer Provides Seville Drivers with New Data	N/T	4/6	4	(1.0)
GM Electric? Waiting for a Battery?	N/T	4/6	10	(0.7)
Plastic Film Forms Throwaway Parachute	Scan	4/6	66	(0.5)
Pivot-Wing Aircraft to be Flight Tested	N/T	4/20	4	(0.7)
Flight Tests Start for Tilt Rotor	N/T	5/11	4	(0.5)
New Car Tester Promises Accurate Emissions, Efficiency Data	N/T	5/11	6	(0.7)
Andretti: 'The Fastest 500'	Wise	5/11	18	(6.0)
Coming: 10,000 Electric and Hybrid Vehicles?	N/T	5/25	10	(0.6)
Electric Actuator Opens Sports-Car Canopy	N/T	6/22	4	(1.0)
Fighter of the Future Poised for Flight	Wise	6/22	20	(5.0)
Air Force Shows a Digital Cockpit System	N/T	7/6	8	(0.6)
Huge Space Structures from 'Tinkertoys for Geniuses'	N/T	7/6	10	(0.8)
Space Beam Maker Demonstrated	N/T	7/20	4	(0.8)
Coming: Real-World Data on Tire Rolling Resistance	N/T	7/20	8	(0.8)
Triple Assault on Sun-Earth Secrets	Zimmerman	7/20	26	(3.0)
Mustang, Capri Buck Downsizing Trend	Wise	8/10	26	(5.0)
Pioneer: Probing Beneath the Venusian Veil	Zimmerman	8/24	21	(4.0)
Feds Catch Up with Light Trucks	N/T	9/7	4	(0.8)
Technology Gets Back to Basics	Aronson	9/7	18	(6.0)
Bonded Bus Snaps Together	Aronson	9/7	28	(3.0)
Dash 400: 'Most Advanced Airliner of the '80s'	N/T	9/21	16	(0.8)
GM's Resized E Cars	Wise	9/21	24	(6.0)
Largest Balsa-Cored FRP Boat Being Built	N/T	10/12	8	(0.5)
Boeing Tools-Up for a Model Change	N/T	10/26	24	(5.0)
Countdown for the Venus Finale	Zimmerman	12/7	32	(4.0)
Vintage Year for EVs	Wise	12/7	40	(5.0)
Speaker Vibes Implant Electrode	Scan	3/9	50	(0.5)
Coming: The Computerized Personal Heart Monitor	N/T	3/23	12	(0.6)
Pyrotechnic Charge Sterilizes Canister	Scan	9/7	42	(0.6)
System Spots Forged Signature as It's Being Written	N/T	10/26	6	(1.0)
Technology for the Handicapped	Zimmerman	11/9	24	(5.0)
Life Raft Can't Tell Top from Bottom	Scan	5/25	38	(0.5)
Toy Safety Isn't Child's Play	Aronson	12/7	24	(5.0)
Time Capsule Expels Gas Well Water	Scan	5/25	40	(0.5)
Ballbarrow: Successor to the Wheelbarrow?	N/T	7/6	6	(0.5)

99. Unclassified

Colin Carmichael 1905-1978	N/T	11/23	4	(0.5)

CLASSIFICATION SYSTEM

The classification system provides nine major (one-digit) classifications, each of which has up to nine (two-digit) sub-classifications. These, in turn, are divided into ten (three-digit) indexing classifications.

Indexing classifications ending in 0 (General) are used to index material concerning several or all indexing classifications ending in 1 through 8. Classifications ending in 9 (Other) are used for material falling within the sub-classification but not within any of the items 1 through 8.

1 ELECTRICAL AND ELECTRONIC

11 Motors and electromechanical actuators
110 General
111 Ac and dc fractional horsepower
112 Ac and dc integral horsepower
113 Universal
114 Gearmotors
115 Torque
116 Servomotors, stepping motors
117 Definite and special-purpose
118 Solenoids, linear motors, electromechanical actuators
119 Other

12 Motor controls and protectors
120 General
121 Ac variable-speed controllers and drive systems, eddy current drives
122 Dc variable-speed controllers and drive systems
123 Stepper-motor controllers and drive systems
124 Servoamplifiers and servosystems
125 Electromagnetic and solid state starters (contactors)
126 Manual starters
127 Current and voltage-responsive protectors
128 Temperature-responsive protectors
129 Other (electronic brakes)

13 Switches and relays
130 General
131 Manual (pushbutton, lever, rotary, interlocks)
132 Thermally operated
133 Pressure or flow operated
134 Limit
135 Proximity, photoelectric
136 Stepping
137 Relays, meter relays, time-delay relays, reed devices
138 Matrix, keyboards
139 Other

14 Circuit Components
140 General
141 Passive (resistors, capacitors, potentiometers)
142 Discrete solid-state (thyristors, transistors, diodes)
143 Digital circuit modules (logic gates, microprocessors, semiconductor memory, oscillators, clocks, card logic)
144 Analog circuit modules (amplifiers, a/d and d/a converters)
145 Interface modules (power and special function circuits, drivers, voltage regulators)
146 Noise filters
147 Optoelectronic devices including sources and detectors (lasers, photocells, LEDs)
148 Display components (alphanumeric LEDs, gas discharge, CRTs, indicator lights)
149 Other

15 Miscellaneous components
150 General
151 Magnets
152 Insulation, shielding
153 Light sources
154 Heaters, heating elements
155 Cooling elements, heat sinks
156 Chassis, racks, control panels
157 Protective devices (fuses, GFIs, circuit breakers, transient protection)
158 Optical materials (lenses, prisms, fiber optics)
159 Other (radio, radar, communications gear and support equipment)

16 Interconnections
160 General
161 Wire terminals
162 Plugs, receptacles, connectors
163 Conductors (cable, harness, coil, busses)
164 Wiring hardware (markers, ties, ducts, cable carriers)
165 Printed, stamped circuits, wire-wrap cords
166 Matrix boards
167 Card cages, frames, control-panel mounts
168 Breadboards
169 Other

17 Control systems and computers
170 General
171 Timers, counters, sequence controllers, dedicated controllers
172 Programmable control, micro-mini-computer systems, NC
173 Calculators
174 Scientific computers (analysis, batch processing, CAD)
175 Input-output devices (teletypewriters, CRT, tape readers and support equipment, digital plotters)
176 Bulk memory
177
178 Time-sharing services, software services
179 Other (radio control)

18 Power supplies, conditioners and controls
180 General
181 Batteries, battery chargers
182 Solar cells, fuel cells, thermionic
183 Ac and dc generators
184 Converters, inverters (rectifiers)
185 Power supplies (modular, uninterruptible)
186 Power controllers (on-off, proportional, phase, zero-voltage)
187 Voltage regulators, transformers
188
189 Other

19 Instrumentation
190 General
191 Sensors and transducers (pressure, load, temperature, position, strain, chemical composition, shaft encoders, lvdts, load cells, thermocouples)
192 Bench-top signal sources and conditioners (signal generators, amplifiers, modulators, demodulators)
193 Readout and recording devices (panel meters, oscilloscopes, oscillographs, chart recorders, x-y recorders, cameras, TV monitors, electronic monitoring systems)
194 Electrical measuring devices (multi-meters, bridges)
195 Digital device testers (probes, bench-top testers, consoles, logic analyzers)
196 Software development systems
197 Data acquisition and conditioning systems (spectrum analyzers)
198 Production test systems
199 Other (strobes)

2 FLUID POWER

21 Fluids
210 General
211 Hydraulic fluids
212
213
214
215
216
217
218 Aerosols, pressurized liquids
219 Other (heat transfer, leak detectors)

22 Fluid conditioners
220 General
221 Fluid storage, pressure vessels, reservoirs
222 Filters, strainers, screens, baffles
223 Renovators (FRLs)
224 Heat exchangers
225 Coolers, radiators, heat pipes
226 Heaters, burners
227 Driers, evaporators
228 Humidifiers, mixers, carburetors
229 Other

23 Fluid conductors
230 General
231 Tubing (pressure)
232 Hose, ducts, bellows
233 Pipe
234 Fittings
235 Joints, couplings, unions, flanges, adapters
236 Mufflers
237
238 Applicators, dispensers
239 Other

24 Linear devices
240 General
241 Cylinders, pistons, cylinder mounts
242 Accumulators
243 Intensifiers, boosters, rams
244 Actuators, bellows, diaphragms
245 Pumps
246 Motors
247
248 Compensators
249 Other

25 Rotary devices
250 General
251 Pumps, rotary, centrifugal
252 Fluid motors, brakes
253 Air motors
254 Compressors, vacuum pumps
255 Rotary actuators
256 Winches
257
258 Centrifuges
259 Other (load adapters)

26 Seals
260 General
261 Material seals (O-rings)
262 Mechanical seals
263 Gaskets
264 Wiper rings, piston rings
265 Packings
266 Labyrinths
267 Diaphragms, rolling diaphragms
268 Bellows, protective covers
269 Other

27 Valves
270 General
271 Directional control
272 Flow control, faucets, flow dividers
273 Pressure control, relief, vacuum breakers, check valves
274 Servovalves
275 Valve blocks, manifolds
276 Nozzles, venturies, orifices, poppets
277 Proportional flow or pressure
278
279 Other

28 Instruments and controls
280 General
281 Test stands, test equipment
282 Control panels, controls
283 Meters, gages (manometers, flow meters, rotameters, anemometers, indicators, flow sensors)
284 Switches, liquid level
285 Transducers (to hydraulic)
286 Regulators
287 Fluid logic, fluidics, moving-part logic
288
289 Other (pneumatic timers, counters)

29 Systems and assemblies
290 General
291 Industrial hydraulic & pneumatic systems
292 Mobile, aircraft marine
293 Servosystems
294 Hydrostatic drives
295 Vacuum
296
297 Hydraulic, pneumatic computers
298 Power units
299 Other

3 MECHANICAL

31 Power sources
310 General
311 Jet engines, turbines
312 Internal combustion engines
313
314 Atomic, nuclear power
315 Exotic fuel engines, rockets
316 Fuels, propellants (explosives, coal, natural gas, hydrogen, fuel oil)
317 Steam
318 Geothermal, wind, water, solar, tidal
319 Other

32 Constant-speed drives and transmissions
320 General
321 Chain
322 Belt
323
324 Gear (speed reducers)
325 Reversing
326
327
328
329 Other

33 Adjustable-speed drives and transmissions
330 General
331 Chain
332 Belt
333 Friction (ball, disc, wheel, cone)
334 Variable stroke
335 Gear drives, differentials
336 Power takeoffs, transfer cases, load adapters
337
338
339 Other

34 Drive components
340 General
341 Transmission chain
342 Belts
343 Gears, racks, pinions
344 Sprockets
345 Pulleys, sheaves, idlers, tensioners
346 Conveyor chain, conveyor belts
347 Conveyor screws, roller conveyors
348
349 Other

35 Rotational components
350 General
351 Antifriction bearings (rolling element, pillow blocks)
352 Sleeve bearings (gas, solid-lubricant, bushings, rod ends, ball joints)
353 Flexible couplings, universal joints, flexible shafts
354 Torque converters, fluid couplings
355 Shafts, axles, splines, crankshafts, spindles, hubs
356 Clutches, brakes, power absorbers, torque limiters
357 Fans, blowers, propellers
358 Reels, winches, hoists
359 Other (flywheels)

36 Mechanisms
360 General
361 Cams, cam followers
362 Linkages, cranks
363 Intermittent-motion, periodic-motion, indexing, gyratory-motion, mechanical escapements, ratchets
364 Three-dimensional
365 Motion converters, leadscrews, jacks, actuators
366 Spring motors
367 Telescoping members, collapsing members, gas springs
368 Manipulators, vibrators, robots, separators
369 Other

37 Controls
370 General
371 Push-pull, cable control
372 Transducers (to mechanical)
373 Gyroscopes
374 Mechanical counters and timers
375 Safety devices
376
377
378
379 Other

38 Subsystems
380 General
381 Slides, ways
382 Positioning and indexing tables
383 Machine bases
384 Machine and instrument subassemblies
385 Vehicle frames, chassis, power trains
386 Refrigeration, air conditioning
387 Lubricants, lubricating systems
388 Robots
389 Other

4 ASSEMBLY COMPONENTS

41 Fasteners
410 General
411 Inserts
412 Nuts, locknuts
413 Pins, dowels, staples
414 Quick operating panel-type, latches
415 Retaining rings, keys, collars, frictional shaft connectors, shaft-hub connectors, tolerance rings
416 Rivets, blind rivets
417 Screws, bolts, studs, shear bolts
418 Washers, grommets, eyelets, spacers, bushings, stand-offs
419 Other (spring clips, clamps, zippers, wire ties, belt splicing, captive panel hardware, captive fasteners)

42 Spring and isolation devices
420 General
421 Fluid and air springs
422 Helical wire springs
423 Leaf, wave, Belleville, coil, and cantilever springs
424 Vibration isolators, mounts, bumpers
425 Hydraulic-damping devices, shock absorbers, snubbers
426 Mechanical damping devices
427 Spring-loaded devices
428
429 Other

43 Miscellaneous
430 General
431 Locks
432 Nameplates, labels, wire markers, signs
433 Dials, knobs, handles, drawer pulls
434 Shims
435 Enclosures, housings, cabinets, cases, adapters
436 Wheels, tires, rollers, casters, ball transfers, rings, glides
437 Plugs, closures (permanent and temporary protective devices)
438 Hinges, brackets
439 Other (razor blades, brushes, bells, knives, buzzers, chimes, bases, boots, bellows, way protectors, bumpers)

44 Measurement equipment
440 General
441 Inspection and testing tools and fixtures
442 Gage blocks, micrometer heads
443 Meters, gages
444 Scales and weighing systems
445 Dimensional measuring systems

5 MATERIALS

51 Ferrous metals
510 General
511 Cast iron, malleable iron, cast carbon, alloy steels
512 Wrought carbon, alloy steels
513 Free-machining steels
514 Stainless steels, high alloys, high temperature steels
515 Specialty steels (tool, die, electrical)
516
517 High-strength low alloys
518 Magnetic alloys
519 Other

52 Nonferrous metals
520 General
521 Aluminum
522 Copper, brass, bronze, beryllium copper
523 Magnesium
524 Nickel
525 Titanium
526 Zinc
527 Refractory metals (tungsten, tantalum, molybdenum, columbium)
528 Precious metals
529 Other (tin, lead, chromium, vanadium)

53 Plastics
530 General
531 Thermoplastic plastics (nylon, teflon)
532 Thermosetting plastics (epoxy, phenolic filled silicones, rigid urethanes)
533 Laminated plastics, vulcanized fiber
534 Reinforced, filled plastics
535 Porous plastics
536
537 Plastic trim and decoration
538 Stock shapes (structural, film, tape, screen)
539 Other

54 Rubber and elastomer
540 General
541 Natural rubber
542 Synthetic rubber
543 Elastomeric plastics (flexible silicones and urethanes)
544 Hard rubber
545
546
547
548 Stock shapes (structural, sponge)
549 Other

55 Joining materials
550 General
551 Adhesives, sealants, encapsulants, caulking, grout
552 Welding rods
553 Brazing, soldering alloys
554
555
556
557
558
559 Other

56 Other nonmetals
560 General
561 Carbon, graphite, diamonds
562 Glass, ceramics, quartz
563 Refractory materials, mica
564 Carbides, cermets
565 Mineral, synthetic, and natural fibers, felt, fabrics
566 Insulating materials (thermal, sound)
567 Wood, cork, composition board, paper
568 Chemicals, phosphors, inks
569 Other (abrasives, friction materials, synthetic crystals, liquid crystals)

57 Finishes, coatings and lubricants
570 General
571 Metallic coatings
572 Chemical coatings, electrochemical coatings, photosensitive
573 Organic finishes (lacquers, synthetic enamels, paints, varnishes)
574 Porcelain enamels, vitreous and ceramic coatings
575 Plastic coatings, plastic powders
576 Lubricating materials
577 Cleaners, solvents
578 Mechanical surface finishes
579 Other (corrosion inhibitors)

58 Prefabricated forms
580 General
581 Metal film tape, foil
582 Wire, wire cloth, knitted wire mesh, wire rope, cable, hoisting chain and fittings
583 Patterned, perforated, expanded metals, textured, prefinished
584 Laminates, clad metals
585 High modulus composite materials (boron, graphite, metal-matrix)
586 Structures (honeycomb, foam, sandwich, isogrids, geodesic)
587 Stock metal shapes (sheet, plate, tubing channels)
588 Balls, beads
589 Other

6 MANUFACTURING PROCESSES

61 Metal casting
610 General
611 Sand
612 Shell mold
613 Permanent mold, gravity, low-pressure
614 Centrifugal
615 Investment
616 Die
617 Plaster mold
618 Continuous
619 Other

62 Metal shaping
620 General
621 Forging, cold forging
622 Extrusion, impact extrusion
623 Heading, upsetting, cold forming
624 Thread, form rolling
625 Powder metallurgy, porous metals, fiber metals
626
627
628 Hot isostatic pressing
629 Other

63 Metal forming
630 General
631 Sheet forming, plate forming
632 Stamping, drawing, blanking, embossing, coining
634 Spinning
635 Roll forming
636 Tube forming
637 Wire forming
638 Stretch and compression forming
639 Other (magnetic forming, electrodeposition)

64 Metal joining
640 General
641 Arc welding
642 Gas welding
643 Resistance welding
644 High-energy welding (plasma, electron beam, explosive bonding, ultrasonic, magnetic, solid state)
645 Flame cutting
646 Brazing
647 Soldering, desoldering
648 Adhesive joining, bonding
649 Other (interlocking, keylock, dovetail, sewing, bolted joints, riveting, glass to metal seals)

65 Metal removal
650 General
651 Planing, broaching
652 Lathe turning, screw machining
653 Milling, hobbing, gear shaping, sawing
654 Drilling, boring, tapping
655 Grinding, abrasive machining
656 Honing, lapping, polishing, burnishing
657 High-energy machining (spark, laser, water jet)
658 ECM, EDM
659 Other

66 Metal treating
660 General
661 Heat treating
662 Surface treating (carburizing, nitriding)
663 Shot peening, surface working
664 Chemical milling, etching, photochemical machining
665
666
667
668
669 Other (impregnation)

67 Finishing
670 General
671 Chemical, solvent cleaning
672 Mechanical finishing, tumbling
673 Conversion coating, anodizing, electropolishing
674 Electroplating, vacuum metallizing, ion deposition
675 Metal spraying, flame spraying, hard facing, plasma spray, plasma arc, electrostatic
676 Painting
677 Hot stamping (branding)
678
679 Other

68 Plastics and rubber processes
680 General
681 Molding, injection molding
682 Extrusion, pultrusion
683 Sheet forming
684 Laminating
685 Casting
686 Stamping, machining, fabricating, forming, forging
687 Calendering, coating, plating
688 Encapsulating
689 Other (filament winding, welding)

69 Production machinery and plant equipment
690 General
691 Assembly, automatic assembly, micro-assembly, welding, soldering joining
692 Packaging, storage, shipping (machines, tools, expendable supplies)
693 Balancing machines
694 Machine tools, presses, metal and plastic fabricating, molding casting, and forming equipment
695 Surface finishing machinery (painting, plating, grinding, buffing)
696 Heating and cooling equipment (furnaces)
697 Electronic-fabricating machinery, hand tools, services
698 Production fixtures and hand tools
699 Other (misc. plant equipment, custom-built machinery)

7 DESIGN THEORY AND TECHNIQUES

71 Design analysis
710 General
711 Applied mechanics (statics, dynamics, stress analysis, shock and vibration, fatigue, elastic-plastic effects, material characterization)
712 Kinematics
713 Mechanical analysis
714 Electrical circuit analysis
715 Hydraulic-circuit analysis
716
717 Durability and reliability (wear resistance, temperature extremes, corrosion resistance)
718 Value analysis, costs, producibility
719 Other

72 Applied mathematics
720 General
721 Statistics, probability, life prediction
722 Optimization
723 Simulation, mathematical modeling
724 Computer-aided analysis
725 Computer programming
726 Matrix methods
727
728
729 Other

73 Basic science
730 General
731 Electromagnetic effects
732 Optics
733 Acoustics, ultrasonics
734 Heat transfer
735 Aerodynamics
736 Radiation, nuclear
737 Chemical effects
738 Materials science, physics
739 Other

74 Human factors
740 General
741 Human limitations, accommodation
742 Aesthetics

75 Legal and environmental
750 Product liability
751 Warranties
752 OSHA
753 Product regulations
754 Antipollution
755 Recycling
756 Energy conservation
757 Litigation, expert witness
758 Patents, copyrights
759 Other

76 Metrication
760 General
761 Mechanical
762 Fluid power
763 Electrical
764 Fasteners

8 ENGINEERING MANAGEMENT AND OPERATION

81 Engineering department operations
810 General
811 Structure, organization
812 Costs, budgets
813 Programming, planning
814 Personnel policies, motivation
815 Recruiting, evaluation, training
816 Management development
817 Compensation, pensions
818 Communication
819 Other

82 Product planning and marketing
820 General
821 Product-concept development
822 Market and feasibility studies
823 Project management
829 Other

83 Drafting and reproduction
830 General
831 Management, control systems
832 Drafting practices, toleranc ing, dimensioning, graphic analysis
833 Technical illustration
834 Drafting equipment
835 Reproduction equipment, systems
836 Furniture, files
837
838
839 Other

84 Laboratory and testing
840 General
841 Component and product testing
842 Experimental design, prototyping

85 Technical information
850 General
851 Engineering libraries, files, books, museums
852 Information classification, retrieval
853 Specifications, standards
854 Report writing, articles, papers, oral
855 Part numbering, part names (nomenclature)
856 Engineering records
857
858 Security, protection
859 Other

87 Personal and professional
870 General
871 Creativity, inventiveness
872 Meetings, shows
873 Contests, awards
874 Societies
875 Professional licensing, certification
876 Unions
877 Education, seminars
878 Career planning
879 Other

88 Outside services
880 General
881 Engineering design services
882 Industrial design services
883 Consulting

9 MISCELLANEOUS

91 Complete machines
910 General
911 Ordnance: tanks, missiles, rockets, ammunition (SIC 19)
912 Machinery: agricultural, construction, machine tools, office machines, materials handling (SIC 35)
913 Electrical machinery: communication, radio, radar, TV, appliances, X-ray (SIC 36)
914 Transportation: automotive, aircraft, ships, railroad, spacecraft, undersea craft (SIC 37)
915 Instruments: medical, dental, photographic, watches (SIC 38)
916 Fabricated metal products: hand tools (SIC 34)
917 Toys, playground equipment, sports equipment, recreational equipment
918
919

99 Unclassified
990 General